



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Techmaster Asia (Thailand) Co., Ltd.
99/28-29, Nue Connex House Donmuang, Paholyothin Rd.,
Sanambin, Donmuang Bangkok 10210, Thailand

Fulfills the requirements of

ISO/IEC 17025:2017

and national standard

ANSI/NCSL Z540-1-1994 (R2002)

In the field of

CALIBRATION

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

A handwritten signature in black ink, appearing to be 'J. Stine', is positioned above a horizontal line.

Jason Stine, Vice President

Expiry Date: 29 October 2024

Certificate Number: AC-1736.08



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory
quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

AND

ANSI/NCSL Z540-1-1994 (R2002)

Techmaster Asia (Thailand) Co., Ltd.

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CALIBRATION

Valid to: **October 29, 2024**

Certificate Number: **AC-1736.08**

Acoustics and Vibration

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Sound Level Meters	94 dB, 1 kHz 114 dB, 1 kHz	0.19 dB	Center 326 Sound Level Calibrator

Chemical Quantities

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH – Source ³	4.01 pH 7.00 pH 10.00 pH	0.006 pH 0.013 pH 0.012 pH	pH Solutions
Conductivity – Source ³	84 µS/cm 1 413 µS/cm 5 000 µS/cm 12.88 mS/cm 111.3 mS/cm	1.1 µS/cm 12 µS/cm 41 µS/cm 0.12 mS/cm 0.98 mS/cm	Conductivity Solutions



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage – Source ¹	Up to 220 mV 220 mV to 2.2 V	7.7 $\mu\text{V/V}$ + 0.86 μV 5.9 $\mu\text{V/V}$ + 0.87 μV	Fluke 5700A Multifunction Calibrator
DC Voltage – Source ¹	(2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV	4.2 $\mu\text{V/V}$ + 3.1 μV 3.9 $\mu\text{V/V}$ + 14 μV 5.9 $\mu\text{V/V}$ + 48 μV 7.5 $\mu\text{V/V}$ + 0.76 mV	Fluke 5700A Multifunction Calibrator
DC Voltage – Source ¹	Up to < 330 mV 330 mV to < 3.3 V (3.3 to < 33) V (33 to < 330) V (330 to 1 020) V	17 $\mu\text{V/V}$ + 1.8 μV 9.2 $\mu\text{V/V}$ + 2.2 μV 11 $\mu\text{V/V}$ + 16 μV 15 $\mu\text{V/V}$ + 0.12 mV 15 $\mu\text{V/V}$ + 1.2 mV	Fluke 5522A Multiproduct Calibrator
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	7.2 $\mu\text{V/V}$ + 0.55 μV 7 $\mu\text{V/V}$ + 0.42 μV 6.9 $\mu\text{V/V}$ + 0.86 μV 9.2 $\mu\text{V/V}$ + 38 μV 9.3 $\mu\text{V/V}$ + 0.13 mV	HP 3458A Opt 002 Multimeter
	(1 to 20) kV (20 to 35) kV (35 to 40) kV	20 mV/V 10 mV/V 20 mV/V	HP 3458A Opt 002 Multimeter with Fluke 80K-40 High Voltage Probe
DC Current – Source ¹	Up to 220 μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	48 $\mu\text{A/A}$ + 7.1 nA 41 $\mu\text{A/A}$ + 9.6 nA 42 $\mu\text{A/A}$ + 49 nA 54 $\mu\text{A/A}$ + 0.84 μA 95 $\mu\text{A/A}$ + 15 μA	Fluke 5700A Multifunction Calibrator
	Up to < 0.33 mA (0.33 to < 3.3) mA (3.3 to < 33) mA (33 to < 330) mA 330 mA to < 1.1 A (1.1 to < 3) A (3 to < 11) A (11 to 20) A	0.12 mA/A + 17 nA 0.078 mA/A + 40 nA 0.078 mA/A + 0.21 μA 0.078 mA/A + 2.1 μA 0.16 mA/A + 32 μA 0.3 mA/A + 32 μA 0.39 mA/A + 0.39 mA 0.78 mA/A + 0.82 mA	Fluke 5522A Multifunction Calibrator
DC Current – Source ¹ Clamp-On Ammeters	(20.5 to < 150) A (150 to 1 025) A	3 mA/A + 0.066 A 3 mA/A + 0.64 A	Fluke 5522A Multifunction Calibrator with 50 Turns Coil

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Current – Measure ¹	Up to 100 nA 100 nA to 1 μA (1 to 10) μA (10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	22 μA/A + 93 pA 18 μA/A + 0.10 nA 28 μA/A + 0.14 nA 30 μA/A + 0.98 nA 30 μA/A + 6.5 nA 30 μA/A + 63 nA 44 μA/A + 1 μA 0.14 mA/A + 12 μA	HP 3458A Opt 002 Multimeter
DC Current – Measure ¹	Up to 1 A (> 1 to 3) A (> 3 to 10) A	0.58 mA/A + 0.64 mA 1.2 mA/A + 1 mA 1.8 mA/A + 6.6 mA	Fluke 8846A Multimeter
DC Current – Measure ¹	Up to 300 A	2.5 mA/A + 1 mA	HP 3458A Opt 002 Multimeter with Empro HA-300-100 Shunt
DC Current – Measure ¹	1 A 2 A (20 to 30) A	0.030 mA 0.068 mA 0.030 % of reading	HP 3458A Opt 002 Multimeter with Standard Shunt Resistance
DC Current – Measure ¹	Up to 1 A (1 to 10) A (10 to 20) A (20 to 30) A	0.12 mA/A + 50 μA 0.49 mA/A + 6 μA 0.88 mA/A + 6 μA 5.6 mA/A + 6 μA	Agilent 3458A Opt 002 Multimeter with Keysight 34330A
AC Voltage – Source ¹	(1 to 2.2) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.34 mV/V + 5.8 μV 0.12 mV/V + 5.1 μV 98 μV/V + 4.9 μV 0.25 mV/V + 4.9 μV 0.67 mV/V + 6.7 μV 1.5 mV/V + 13 μV 0.3 mV/V + 4.9 μV 0.11 mV/V + 4.9 μV 96 μV/V + 4.8 μV 24 μV/V + 4.8 μV 0.6 mV/V + 6 μV 1.3 mV/V + 12 μV 1.7 mV/V + 24 μV 3.2 mV/V + 24 μV	Fluke 5700A Multifunction Calibrator



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Source ¹	(22 to 220 mV		Fluke 5700A Multifunction Calibrator
	(10 to 20) Hz	0.29 mV/V + 14 μV	
	(20 to 40) Hz	0.1 mV/V + 9.4 μV	
	40 Hz to 20 kHz	92 μV/V + 9.2 μV	
	(20 to 50) kHz	0.24 mV/V + 88 μV	
	(50 to 100) kHz	0.55 mV/V + 20 μV	
	(100 to 300) kHz	1.1 mV/V + 24 μV	
	(300 to 500) kHz	1.7 mV/V + 30 μV	
	500 kHz to 1 MHz	3.2 mV/V + 53 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.23 mV/V + 54 μV	
	(20 to 40) Hz	0.11 mV/V + 19 μV	
	40 Hz to 20 kHz	54 μV/V + 10 μV	
	(20 to 50) kHz	88 μV/V + 14 μV	
	(50 to 100) kHz	0.13 mV/V + 38 μV	
	(100 to 300) kHz	0.5 mV/V + 96 μV	
	(300 to 500) kHz	1.2 mV/V + 0.24 mV	
	500 kHz to 1 MHz	2 mV/V + 0.35 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.3 mV/V + 0.54 mV	
	(20 to 40) Hz	0.12 mV/V + 0.20 mV	
	40 Hz to 20 kHz	53 μV/V + 67 μV	
	(20 to 50) kHz	91 μV/V + 0.13 mV	
	(50 to 100) kHz	0.12 mV/V + 0.26 mV	
(100 to 300) kHz	0.33 mV/V + 0.72 mV		
(300 to 500) kHz	1.2 mV/V + 2.4 mV		
500 kHz to 1 MHz	1.2 mV/V + 3.8 mV		
(22 to 220) V			
(10 to 20) Hz	0.3 mV/V + 5.4 mV		
(20 to 40) Hz	0.12 mV/V + 1.8 mV		
40 Hz to 20 kHz	59 μV/V + 0.85 mV		
(20 to 50) kHz	99 μV/V + 1.4 mV		
(50 to 100) kHz	0.18 mV/V + 3.1 mV		
(100 to 300) kHz	1.2 mV/V + 19 mV		
220 V to 1.1 kV			
(15 to 50) Hz	0.36 mV/V + 20 mV		
50 Hz to 1 kHz	82 μV/V + 5.5 mV		



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Source ¹	(1 to < 33) mV (10 to 45) Hz > 45 Hz to 10 kHz (>10 to 20) kHz (> 20 to 50) kHz (>50 to 100) kHz (>100 to 500) kHz	0.63 mV/V + 4.9 μV 0.14 mV/V + 4.9 μV 0.18 mV/V + 4.9 μV 0.78 mV/V + 4.9 μV 2.8 mV/V + 10 μV 6.3 mV/V + 39 μV	Fluke 5522A Multiproduct Calibrator
AC Voltage – Source ¹	(33 to < 330) mV (10 to 45) Hz > 45 Hz to 10 kHz (>10 to 20) kHz (> 20 to 50) kHz (>50 to 100) kHz (>100 to 500) kHz (0.33 to < 3.3) V (10 to 45) Hz > 45 Hz to 10 kHz (>10 to 20) kHz (> 20 to 50) kHz (>50 to 100) kHz (>100 to 500) kHz (3.3 to < 33) V (10 to 45) Hz > 45 Hz to 10 kHz (>10 to 20) kHz (> 20 to 50) kHz (>50 to 100) kHz (33 to < 330) V 45 Hz to 1 kHz (> 1 to 10) kHz (> 10 to 20) kHz (> 20 to 50) kHz (>50 to 100) kHz (330 to 1 020) V 45 Hz to 1 kHz (> 1 to 5) kHz (> 5 to 10) kHz	0.25 mV/V + 6.7 μV 0.14 mV/V + 6.5 μV 0.15 mV/V + 6.6 μV 0.29 mV/V + 6.6 μV 0.63 mV/V + 25 μV 1.7 mV/V + 55 μV 0.24 mV/V + 42 μV 0.12 mV/V + 48 μV 0.15 mV/V + 48 μV 0.24 mV/V + 42 μV 0.55 mV/V + 0.1 mV 1.9 mV/V + 0.47 mV 0.24 mV/V + 0.53 mV 0.12 mV/V + 0.49 mV 0.19 mV/V + 0.48 mV 0.28mV/V + 0.48 mV 0.70 mV/V + 1.3 mV 0.15 mV/V + 1.7 mV 0.16 mV/V + 4.9 mV 0.20 mV/V + 4.8 mV 0.24 mV/V + 4.8 mV 1.6 mV/V + 39 mV 0.24 mV/V + 8.3 mV 0.20 mV/V + 8.1 mV 0.24 mV/V + 8.0 mV	Fluke 5522A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	(1 to 10) mV		HP 3458A Opt 002 Multimeter
	(1 to 40) Hz	0.36 mV/V + 3.6 μ V	
	40 Hz to 1 kHz	0.23 mV/V + 1.4 μ V	
	(1 to 20) kHz	0.32 mV/V + 1.7 μ V	
	(20 to 50) kHz	1.2 mV/V + 1.6 μ V	
	(50 to 100) kHz	5.7 mV/V + 2 μ V	
	(100 to 300) kHz	46 mV/V + 2.6 μ V	
	100 mV to 10 V		
	(1 Hz to 40) Hz	72 μ V/V + 0.85 mV	
	40 Hz to 1 kHz	84 μ V/V + 0.26 mV	
	(1 to 20) kHz	0.17 mV/V + 0.26 mV	
	(20 to 50) kHz	0.35 mV/V + 0.25 mV	
	(50 to 100) kHz	0.93 mV/V + 0.27 mV	
	(100 to 300) kHz	3.5 mV/V + 1.2 mV	
	300 kHz to 1 MHz	12 mV/V + 1.2 mV	
	(1 to 2) MHz	18 mV/V + 1.2 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.24 mV + 4.7 mV	
	40 Hz to 1 kHz	0.15 mV + 16 mV	
	(1 to 20) kHz	0.15 mV + 17 mV	
(20 to 50) kHz	0.36 mV + 8.6 mV		
(50 to 100) kHz	1.4 mV/V + 3.9 mV		
(100 to 300) kHz	4.8 mV/V + 12 mV		
300 kHz to 1 MHz	18 mV/V + 12 mV		
100 V to 1 kV			
(1 to 40) Hz	0.46 mV/V + 50 mV		
40 Hz to 1 kHz	0.46 mV/V + 28 mV		
(1 to 20) kHz	0.69 mV/V + 29 mV		
(20 to 50) kHz	1.5 mV/V + 24 mV		
(50 to 100) kHz	3.6 mV/V + 24 mV		
AC High Voltage – Measure ¹	50 Hz (1 to 5) kV (>5 to 10) kV	12 mV/V + 6.2 V 12 mV/V + 6.7 V	Kikusui 149-10A High Voltage Meter
AC High Voltage – Measure ¹	(1 to 40) kV 60 Hz	50 mV/V + 0.11 V	HP 3458A Opt 002 Multimeter with Fluke 80K-40 High Voltage Probe

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Source ¹	(9 to 220) μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.36 mA/A + 25 nA 0.24 mA/A + 16 nA 0.17 mA/A + 12 nA 0.42 mA/A + 18 nA 1.6 mA/A + 95 nA	Fluke 5700A Multifunction Calibrator
AC Current – Source ¹	220 μ A to 2.2 mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (22 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz 220 mA to 2.2 A 20 Hz to 1kHz (1 to 5) kHz (5 to 10) kHz	0.37 mA/A + 73 nA 0.25 mA/A + 68 nA 0.19 mA/A + 54 nA 0.32 mA/A + 0.17 μ A 1.6 mA/A + 0.95 μ A 0.32 mA/A + 0.67 μ A 0.2 mA/A + 0.57 μ A 0.16 mA/A + 0.46 μ A 0.27 mA/A + 0.73 μ A 1.3 mA/A + 5.9 μ A 0.32 mA/A + 6.1 μ A 0.2 mA/A + 5 μ A 0.16 mA/A + 3.4 μ A 1.4 μ A/A + 12 μ A 0.31 mA/A + 44 μ A 0.53 mA/A + 0.11 mA 8.3 mA/A + 0.29 mA	Fluke 5700A Multifunction Calibrator
AC Current – Source ¹	(29 to < 330) μ A (10 to 20) Hz (> 20 to 45) Hz > 45 Hz to 1 kHz (> 1 to 5) kHz (> 5 to 10) kHz (> 10 to 30) kHz 330 μ A to < 3.3 mA (10 to 20) Hz (> 20 to 45) Hz > 45 Hz to 1 kHz (> 1 to 5) kHz (> 5 to 10) kHz (> 10 to 30) kHz	1.6 mA/A + 79 nA 1.2 mA/A + 78 nA 1 mA/A + 82 nA 2.4 mA/A + 0.12 μ A 6.3 mA/A + 0.16 μ A 13 mA/A + 0.32 μ A 1.6 mA/A + 0.14 μ A 1 mA/A + 0.14 μ A 0.78 mA/A + 0.16 μ A 1.6 mA/A + 0.2 μ A 3.9 mA/A + 0.27 μ A 7.8 mA/A + 0.49 μ A	Fluke 5522A Multifunction Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Source ¹	(3.3 to < 33) mA		
	(10 to 20) Hz	1.4 mA/A + 1.7 μA	
	> 20 to 45) Hz	0.7 mA/A + 1.7 μA	
	> 45 Hz to 1 kHz	0.32 mA/A + 1.8 μA	
	> 1 to 5) kHz	0.64 mA/A + 2 μA	
	> 5 to 10) kHz	1.6 mA/A + 2.8 μA	
	> 10 to 30) kHz	3.2 mA/A + 3.2 μA	
	(33 to < 330) mA		
	(10 to 20) Hz	1.4 mA/A + 61 μA	
	> 20 to 45) Hz	0.7 mA/A + 60 μA	
	> 45 Hz to 1 kHz	0.32 mA/A + 61 μA	
	> 1 to 5) kHz	0.78 mA/A + 70 μA	
	> 5 to 10) kHz	1.6 mA/A + 0.1 mA	
	> 10 to 30) kHz	3.2 mA/A + 0.17 mA	
	330 mA to < 1.1 A		Fluke 5522A Multifunction Calibrator
	(10 to 45) Hz	1.4 mA/A + 78 μA	
	> 45 Hz to 1 kHz	0.39 mA/A + 79 μA	
	> 1 to 5) kHz	4.7 mA/A + 0.78 mA	
	> 5 to 10) kHz	20 mA/A + 3.9 mA	
	(1.1 to < 3) A		
	10 to 45) Hz	1.4 mA/A + 78 μA	
	> 45 Hz to 1 kHz	0.47 mA/A + 78 μA	
	> 1 to 5) kHz	4.7 mA/A + 0.78 mA	
	> 5 to 10) kHz	20 mA/A + 3.9 mA	
	(3 to < 11) A		
	> 45 Hz to 100 Hz	0.47 mA/A + 1.7 mA	
	> 100 Hz to 1 kHz	0.78 mA/A + 1.7 mA	
	> 1 to 5) kHz	24 mA/A + 1.8 mA	
	(11 to 20.5) A		
	> 45 Hz to 100 Hz	1 mA/A + 4 mA	
	> 100 Hz to 1 kHz	1.2 mA/A + 4 mA	
	> 1 to 5) kHz	24 mA/A + 4 mA	
AC Current – Source ¹ Clamp-On Ammeters	45 to 65) Hz		Fluke 5522A Multifunction Calibrator with 50 turns Coil
	(20.5 to < 150) A	3.4 mA/A + 0.066 A	
	(150 to 1 025) A	3.4 mA/A + 0.59 A	
	> 65 to 440) Hz		
	(20.5 to < 150) A	10 mA/A + 0.067 A	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Power – Source ¹	0.108 9 mW to < 1.089 W (0.033 to < 33) V (3.3 to < 33) mA	0.2 mW/W + 90 μW	Fluke 5522A Multifunction Calibrator
	1.08 9 mW to < 10.89 W (0.033 to < 33) V (33 to < 330) mA)	0.2 mW/W + 0.9 mW	
	10.89 mW to < 99 W (0.033 to < 33) V (0.33 to < 3) A	0.2 mW/W + 8 mW	
	99 mW to < 660 W (0.033 to < 33) V 3 A to 20 A)	0.6 mW/W + 80 mW	
	(0.108 9 to < 33) W (33 to 1000) V (3.3 to < 33) mA	0.2 mW/W + 0.9 mW	
	(1.089 to < 330) W (33 to 1 000) V (33 to < 330) mA	0.2 mW/W + 9 mW	
	10.89 W to < 3 kW (33 to 1 000) V (0.33 to < 3) A	0.2 mW/W + 90 mW	
	99 W to 20 kW (33 to 1 000) V (3 to 20) A	0.6 mW/W + 0.9 W	
	0.33 W to < 0.544 5 kW (0.033 to < 33) V, (10 to < 16.5) A	3.2 mW/W + 60 mW	
	0.5445 W to < 4.950 kW (0.033 to < 33) V, (16.5 to < 150) A	3.2 mW/W + 0.6 W	
	4.95 W to < 33.825 kW (0.033 to < 33) V, (150 to 1 025) A	3.2 mW/W + 6 W	
	(0.33 to < 16.83) kW (33 to 1 020) V, (10 to < 16.5) A	3.2 mW/W + 0.6 W	
	(0.544 5 to < 153) kW (33 to 1 020) V, 16.5 A to < 150 A)	3.2 mW/W + 6 W	
	4.95 kW to 1.0455 MW (33 to 1 020) V, (150 to 1 025) A	3.2 mW/W + 60 W	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
<p>AC Power – Source¹ @ (45 to 65) Hz Power factor: 1.000</p>	(1.089 to < 29.7) mW (0.33 to < 3.3) V, (3.3 to < 9) mA	1.2 mW/W + 10 μW	<p>Fluke 5522A Multifunction Calibrator</p>
	(2.97 to < 108.9) mW (0.33 to < 3.3) V, (9 to < 33) mA	0.8 mW/W + 10 μW	
	(10.89 to < 297) mW (0.33 to < 3.3) V, (33 to < 90) mA	1.2 mW/W + 0.1 mW	
	29.7 mW to < 1.089 W (0.33 to < 3.3) V, (90 to < 330) mA	0.8 mW/W + 0.1 mW	
	(0.108 9 to < 2.97) W (0.33 to < 3.3) V, (0.33 to < 0.9) A	1.1 mW/W + 1 mW	
	(0.297 to < 7.26) W (0.33 to < 3.3) V, (0.9 to < 2.2) A	0.9 mW/W + 1 mW	
	(0.726 to < 14.85) W (0.33 to < 3.3) V, (2.2 to < 4.5) A	1.2 mW/W + 1 mW	
	(1.485 to < 66) W (0.33 to < 3.3) V, (4.5 to 20) A	1 mW/W + 10 mW	
	(10.89 to < 297) mW (3.3 to < 33) V, (3.3 to < 9) mA	1.2 mW/W + 10 μW	
	29.7 mW to < 1.089 W (3.3 to < 33) V, (9 to < 33) mA	0.8 mW/W + 0.1 mW	
	(0.1089 to < 2.97) W (3.3 to < 33) V, (33 to < 90) mA	1.2 mW/W + 0.1 mW	
	(0.297 to < 10.89) W (3.3 to < 33) V, (90 to < 330) mA	0.8 mW/W + 1 mW	
	(1.089 to < 29.7) W (3.3 to < 33) V, (0.33 to < 0.9) A	1.1 mW/W + 1 mW	
	(2.97 to < 72.6) W (3.3 to < 33) V, (0.9 to < 2.2) A	0.9 mW/W + 10 mW	



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<p>AC Power – Source ¹ @ (45 to 65) Hz Power factor: 1.000</p>	<p>(7.26 to < 148.5) W (3.3 to < 33) V, (2.2 to < 4.5) A</p>	<p>1.2 mW/W + 10 mW</p>	<p>Fluke 5522A Multifunction Calibrator</p>
	<p>(14.85 to < 660) W (3.3 to < 33) V, (4.5 to 20) A</p>	<p>1 mW/W + 0.1 W</p>	
	<p>(0.108 9 to < 2.97) W (33 to < 330) V, (3.3 to < 9) mA</p>	<p>1.2 mW/W + 0.1 mW</p>	
	<p>(0.297 to < 10.89) W (33 to < 330) V, (9 to < 33) mA</p>	<p>0.8 mW/W + 1 mW</p>	
	<p>(1.089 to < 29.7) W (33 to < 330) V, (33 to < 90) mA</p>	<p>1.2 mW/W + 1 mW</p>	
	<p>(2.97 to < 108.9) W (33 to < 330) V, (90 to < 330) mA</p>	<p>0.8 mW/W + 10 mW</p>	
	<p>(10.89 to < 297) W (33 to < 330) V, (0.33 to < 0.9) A</p>	<p>1.1 mW/W + 10 mW</p>	
	<p>(29.7 to < 726) W (33 to < 330) V, (0.9 to < 2.2) A</p>	<p>0.9 mW/W + 0.1 W</p>	
	<p>(72.6 to < 1 485) W (33 to < 330) V, (2.2 to < 4.5) A</p>	<p>1.2 mW/W + 0.1 W</p>	
	<p>(148.5 to < 6 600) W (33 to < 330) V, (4.5 to 20) A</p>	<p>1 mW/W + 1 W</p>	
	<p>(1.089 to < 9) W (330 to 1 000) V, (3.3 to < 9) mA</p>	<p>1.2 mW/W + 0.1 mW</p>	
	<p>(2.97 to < 33) W (330 to 1 000) V, (9 to < 33) mA</p>	<p>0.8 mW/W + 1 mW</p>	
	<p>(10.89 to < 90) W (330 to 1 000) V, (33 to < 90) mA</p>	<p>1.2 mW/W + 1 mW</p>	
	<p>(29.7 to < 330) W (330 to 1 000) V, (90 to < 330) mA</p>	<p>0.8 mW/W + 10 mW</p>	
	<p>(108.9 to < 900) W (330 to 1 000) V, (0.33 to < 0.9) A</p>	<p>1.1 mW/W + 10 mW</p>	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Power – Source ¹ @ (45 to 65) Hz Power factor: 1.000	(297 to < 2 200) W (330 to 1 000) V, (0.9 to < 2.2) A (726 to < 4 500) W (330 to 1 000) V, (2.2 to < 4.5) A (1 485 to 20 000) W (330 to 1 000) V, (4.5 to 20) A	0.9 mW/W + 0.1 W 1.2 mW/W + 0.1 W 1 mW/W + 1 W	Fluke 5522A Multifunction Calibrator
AC Power – Source ¹ @ (45 to 65) Hz Power factor: 1.000	(2.97 to < 108.9) W (33 to < 330) V, (90 to < 330) mA (10.89 to < 297) W (33 to < 330) V, (0.33 to < 0.9) A (29.7 to < 726) W (33 to < 330) V, (0.9 to < 2.2) A (72.6 to < 1 485) W (33 to < 330) V, (2.2 to < 4.5) A (148.5 to < 6 600) W (33 to < 330) V, (4.5 to 20) A (1.089 to < 9) W (330 to 1 000) V, (3.3 to < 9) mA (2.97 to < 33) W (330 to 1 000) V, (9 to < 33) mA (10.89 to < 90) W (330 to 1 000) V, (33 to < 90) mA (29.7 to < 330) W (330 to 1 000) V, (90 to < 330) mA (108.9 to < 900) W (330 to 1 000) V, (0.33 to < 0.9) A	0.8 mW/W + 10 mW 1.1 mW/W + 10 mW 0.9 mW/W + 0.1 W 1.2 mW/W + 0.1 W 1 mW/W + 1 W 1.2 mW/W + 0.1 mW 0.8 mW/W + 1 mW 1.2 mW/W + 1 mW 0.8 mW/W + 10 mW 1.1 mW/W + 10 mW	Fluke 5522A Multifunction Calibrator



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Power – Source ¹ @ (45 to 65) Hz Power factor: 1.000	(297 to < 2 200) W (330 to 1 000) V, (0.9 to < 2.2) A	0.9 mW/W + 0.1 W	Fluke 5522A Multifunction Calibrator
	(726 to < 4 500) W (330 to 1 000) V, (2.2 to < 4.5) A	1.2 mW/W + 0.1 W	
	(1 485 to 20 000) W (330 to 1 000) V, (4.5 to 20) A	1 mW/W + 1 W	
AC Power – Source ¹ @ (45 to 65) Hz Power factor: (0.500 to 0.999)	(0.545 to < 29.67) mW (0.33 to < 3.3) V, (3.3 to < 9) mA	4 mW/W + 10 μW	Fluke 5522A Multifunction Calibrator
	(1.485 to < 108.8) mW (0.33 to < 3.3) V, (9 to < 33) mA	4 mW/W + 10 μW	
	(5.45 to < 296.7) mW (0.33 to < 3.3) V, (33 to < 90) mA	4 mW/W + 0.1 mW	
	14.85 mW to < 1.088 W (0.33 to < 3.3) V, (90 to < 330) mA	4 mW/W + 0.1 mW	
	(54.45 to < 2.967) W (0.33 to < 3.3) V, (0.33 to < 0.9) A	4 mW/W + 1 mW	
	0.1485 to < 7.2527 W (0.33 to < 3.3) V, (0.9 to < 2.2) A	4 mW/W + 1 mW	
	(0.363 to < 14.835) W (0.33 to < 3.3) V, (2.2 to < 4.5) A	4 mW/W + 1 mW	
	(0.7425 to < 65.934) W (0.33 to < 3.3) V, (4.5 A to 20) A	4 mW/W + 10 mW	
	(5.45 to < 296.7) mW (3.3 to < 33) V, (3.3 to < 9) mA	4 mW/W + 10 μW	
	14.85 mW to < 1.088 W (3.3 to < 33) V, (9 to < 33) mA	4 mW/W + 0.1 mW	
	54.45 mW to < 2.967 W (3.3 to < 33) V, (33 to < 90) mA	4 mW/W + 0.1 mW	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Power – Source ¹ @ (45 to 65) Hz Power factor: (0.500 to 0.999)	(0.148 5 to < 10.88) W (3.3 to < 33) V, (90 < 330) mA	4 mW/W + 1 mW	Fluke 5522A Multifunction Calibrator
	(0.544 5 to < 29.67) W (3.3 to < 33) V, (0.33 to < 0.9) A	4 mW/W + 1 mW	
	(1.485 to < 72.527) W (3.3 to < 33) V, (0.9 to < 2.2) A	4 mW/W + 10 mW	
	(3.63 to < 148.35) W (3.3 to < 33) V, (2.2 to < 4.5) A	4 mW/W + 10 mW	
	(7.425 to < 659.34) W (3.3 to < 33) V, (4.5 to 20) A	4 mW/W + 0.1 W	
	54.45 mW to < 2.967 W (33 to < 330) V, (3.3 to < 9) mA	4 mW/W + 0.1 mW	
	(0.148 5 to < 10.88) W (to < 330) V, (9 to < 33) mA	4 mW/W + 1 mW	
	(0.544 5 to < 29.67) W (to < 330) V, (to < 90) mA	4 mW/W + 1 mW	
	(1.485 to < 108.8) W (33 to < 330) V, (90 to < 330) mA	4 mW/W + 10 mW	
	(5.445 to < 296.7) W (33 to < 330) V, (0.33 to < 0.9) A	4 mW/W + 10 mW	
	(14.85 to < 725.27) W (33 to < 330) V, (0.9 to < 2.2) A	4 mW/W + 0.1 W	
	(36.3 to < 1483.5) W (33 to < 330) V, (2.2 to < 4.5) A	4 mW/W + 0.1 W	
	(74.25 to < 6593.4) W (33 to < 330) V, (4.5 to 20) A	4 mW/W + 1 W	



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Power – Source ¹ @ (45 to 65) Hz Power factor: (0.500 to 0.999)	(0.544 5 to < 8.991) W (330 to 1000) V, (3.3 to < 9) mA	4 mW/W + 0.1 mW	Fluke 5522A Multifunction Calibrator
	(1.485 to < 32.97) W (330 to 1000) V, (9 to < 33) mA	4 mW/W + 1 mW	
	(5.445 to < 89.91) W (330 to 1 000) V, (33 to < 90) mA	4 mW/W + 1 mW	
	(14.85 to < 329.7) W (330 to 1 000) V, (90 to < 330) mA	4 mW/W + 10 mW	
	(54.45 to < 899.1) W (330 to 1 000) V, (0.33 to < 0.9) A	4 mW/W + 10 mW	
	(148.5 to < 2197.8) W (330 to 1 000) V, (0.9 to < 2.2) A	4 mW/W + 0.1 W	
	(363 to < 4 495.5) W (330 to 1 000) V, (2.2 to < 4.5) A	4 mW/W + 0.1 W	
	(742.5 to 19 980) W (330 to 1 000) V, (4.5 A to 20) A	4 mW/W + 1 W	
AC Power – Source ¹ @ (45 to 65) Hz Power factor: 1.000	3.3 W to < 16.83 kW (0.33 to 1 020) V, (10 to < 16.5) A	3.6 mW/W + 0.6 W	Fluke 5522A Multifunction Calibrator with with 50 Turns coil
	5.445 W to < 153 kW (0.33 to 1 020) V, (16.5 to < 150) A	3.6 mW/W + 6 W	
	49.5 W to 1.045 5 MW (0.33 to 1 020) V, (150 to 1 025) A	3.6 mW/W + 60 W	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Power – Source ¹ @ (45 to 65) Hz Power factor: (0.500 to 0.999)	1.65 W to < 16.813 kW (0.33 to 1 020) V, (10 to < 16.5) A 2.723 W to < 152.85 kW (0.33 to 1 020) V, (16.5 to < 150) A 24.75 W to 1.044 4 MW (0.33 to 1 020) V, (150 to 1 025) A	5 mW/W + 0.6 W 5 mW/W + 6 W 5 mW/W + 60 W	Fluke 5522A Multifunction Calibrator with with 50 Turns coil
AC Current – Measure ¹	Up to 100 µA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz 100 µA to 100 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	4.7 mA/A + 36 nA 1.8 mA/A + 35 nA 0.71 mA/A + 35 nA 0.7 mA/A + 35 nA 4.7 mA/A + 24 µA 1.8 mA/A + 24 µA 0.71 mA/A + 24 µA 0.36 mA/A + 23 µA 0.71 mA/A + 24 µA 4.7 mA/A + 47 µA 6.5 mA/A + 0.18 mA 4.7 mA/A + 0.24 mA 1.9 mA/A + 0.24 mA 0.95 mA/A + 0.24 mA 1.1 mA/A + 0.26 mA 3.5 mA/A + 0.24 mA 12 mA/A + 0.47 mA	Agilent 3458A Opt 002 Multimeter
AC Current – Measure ¹	(0.1 to 1) A 10 Hz to 1 kHz (> 1 to 5) kHz (> 1 to 3) A 10 Hz to 1 kHz (> 1 to 5) kHz (> 3 to 10) A 10 Hz to 1 kHz (> 1 to 5) kHz	1.2 mA/A + 1.3 mA 1.2 mA/A + 1.3 mA 1.8 mA/A + 2.7 mA 1.8 mA/A + 20 mA 1.8 mA/A + 14 mA 1.8 mA/A + 17 mA	Fluke 8846A Multimeter



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Measure ¹	50Hz 1 A 5 A 10 A 15 A 20 A (20 to 30) A 50 Hz to 1 kHz 10 A (1 to 5) kHz 10 A	3 mA 5 mA 10 mA 20 mA 30 mA 70 mA 13 mA 0.2 A	Agilent 3458A Opt 002 Multimeter with Keysight 34330A Standard Shunt Resistor
Resistance – Source ¹	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ 330 MΩ to 1.1 GΩ	32 μΩ/Ω + 0.78 mΩ 24 μΩ/Ω + 1.2 mΩ 22 μΩ/Ω + 1.1 mΩ 22 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 16 mΩ 22 μΩ/Ω + 0.16 Ω 22 μΩ/Ω + 0.16 Ω 25 μΩ/Ω + 1.9 Ω 25 μΩ/Ω + 2.2 Ω 49 μΩ/Ω + 28 Ω 0.11 mΩ/Ω + 56 Ω 0.2 mΩ/Ω + 2.5 kΩ 0.39 mΩ/Ω + 3.7 kΩ 2.4 mΩ/Ω + 87 kΩ 12 mΩ/Ω + 0.4 MΩ	Fluke 5522A Multifunction Calibrator
Resistance – Measure ¹ Fixed Points	10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ	22 μΩ/Ω + 62 μΩ 18 μΩ/Ω + 0.61 mΩ 16 μΩ/Ω + 0.73 mΩ 15 μΩ/Ω + 13 mΩ 15 μΩ/Ω + 67 mΩ 21 μΩ/Ω + 2.7 Ω 46 μΩ/Ω + 0.39 kΩ 0.56 mΩ/Ω + 1.2 kΩ 6 mΩ/Ω + 12 kΩ	HP 3458A Opt 002 Multimeter



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance – Source ¹ Fixed Points	1 Ω	0.12 mΩ	Fluke 5700A Multifunction Calibrator
	1.9 Ω	0.22 mΩ	
	10 Ω	0.28 mΩ	
	19 Ω	0.58 mΩ	
	100 Ω	1.3 mΩ	
	190 Ω	2.4 mΩ	
	1 kΩ	10 mΩ	
	1.9 kΩ	20 mΩ	
	10 kΩ	90 mΩ	
	19 kΩ	0.19 Ω	
	100 kΩ	1.3 Ω	
	190 kΩ	2.5 Ω	
Resistance – Source ¹ Fixed Points	1 MΩ	2.4 Ω	Fluke 5700A Multifunction Calibrator
	1.9 MΩ	47 Ω	
	10 MΩ	0.47 kΩ	
Resistance – Source ¹ Fixed Points	19 MΩ	1.3 kΩ	Fluke 5700A Multifunction Calibrator
	100 MΩ	12 kΩ	
	10 mΩ to 1 kΩ	0.1 mΩ/Ω + 2 mΩ	
(1 to 100) kΩ	0.1 mΩ/Ω + 0.18 Ω		
100 kΩ to 1 GΩ	1 mΩ/Ω + 11 kΩ		
(1 to 10) GΩ	2 mΩ/Ω + 0.58 kΩ		
(10 to 100) GΩ	5 mΩ/Ω + 23 Ω		
Resistance – Source ¹ (Insulation)	@ Voltage 10 V to 5 kV	1.2 mΩ/Ω + 0.78 MΩ 2.4 mΩ/Ω + 6.5 MΩ 5.8 mΩ/Ω + 0.37 GΩ	IET HRRS-Q-3-100M
	100 MΩ to 1 GΩ		
	(1 to 10) GΩ		
	(10 to 100) GΩ		
Resistance – Source ¹ Fixed Points (Insulation)	@ Voltage 10 V to 5 kV	0.59 kΩ 1.2 kΩ 2.9 kΩ 5.9 kΩ 12 kΩ 29 kΩ 59 kΩ 0.12 MΩ 0.30 MΩ	Resistance Box HB1
	100 kΩ		
	200 kΩ		
	500 kΩ		
	1 MΩ		
	2 MΩ		
	5 MΩ		
	10 MΩ		
	20 MΩ		
50 MΩ			



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance – Source ¹	1 kHz (0.4 to < 1.1) nF (1.1 to < 3.3) nF (3.3 to < 11) nF (11 to < 33) nF (33 to < 110) nF (110 to < 330) nF 100 Hz (1.1 to < 3.3) μF (3.3 to < 11) μF (11 to < 33) μF 50 Hz 110 μF	3.9 mF/F + 8.8 pF 3.9 mF/F + 11 pF 2.0 mF/F + 10 pF 2.0 mF/F + 59 pF 2.0 mF/F + 59 pF 2.0 mF/F + 0.58 nF 2.0 mF/F + 6.3 nF 2.0 mF/F + 10 nF 3.2 mF/F + 63 nF 3.5 mF/F + 0.1 μF	Fluke 5522A Multifunction Calibrator
Capacitance – Source ¹	DC 330 μF to < 1.1 mF (1.1 to < 3.3) mF (3.3 to < 11) mF (11 to < 33) mF (33 to 110) mF	3.5 mF/F + 1.0 μF 3.5 mF/F + 6.3 μF 3.5 mF/F + 10 μF 5.9 mF/F + 63 μF 8.6 mF/F + 0.11 mF	Fluke 5522A Multifunction Calibrator
Capacitance – Source ¹ @ 1 kHz	1 pF 10 pF 100 pF 1 nF	1.2 fF 12 fF 0.12 pF 1.2 pF	Hewlett Packard 16380A Air Capacitor Set consisting of 16381A, 16382A, 16383A, and 16384A
Capacitance – Source ¹ Algorithmic Deviation	1 pF (1 to 3) MHz 4 MHz 5 MHz 10 MHz 13 MHz	1.2 fF 1.3 fF 1.5 fF 2.8 fF 3.9 fF	Hewlett Packard 16380A Air Capacitor Set consisting of 16381A, 16382A, 16383A, and 16384A
Capacitance – Source ¹ Algorithmic Deviation	10 pF (1 to 13) MHz	12 fF	
Capacitance – Source ¹ Algorithmic Deviation	100 pF (1 to 10) MHz 13 MHz	0.12 pF 0.13 pF	
Capacitance – Source ¹ Algorithmic Deviation	1 nF (1 to 4) MHz 5 MHz 10 MHz 13 MHz	1.2 pF 1.3 pF 2.2 pF 3 pF	Hewlett Packard 16380A Air Capacitor Set consisting of 16381A, 16382A, 16383A, and 16384A



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Inductance – Source 1 kHz	100 μ H to 1 mH (1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	24 mH/H + 5 μ H 24 mH/H + 0.7 mH 19 mH/H + 8.2 μ H 9.5 mH/H + 0.13 mH 9.5 mH/H + 1.5 mH	IET 1491-G Decade Inductor
Electrical Simulation of Thermocouple Indicating Devices - Source and Measure ¹	Type K (-200 to -50) °C (-50 to 1 372) °C Type T (-200 to -50) °C (-50 to 400) °C Type J (-210 to -50) °C (-50 to -760) °C Type E (-230 to -50) °C (-50 to 1000) °C Type R (0 to 1 768) °C Type S (0 to 250) °C (> 250 to 400) °C (> 400 to 1 000) °C (> 1 000 to 1 767) °C Type N (-200 to -100) °C (> -100 to -25) °C (> -25 to 120) °C (> 120 to 410) °C (> 410 to 1 300) °C	0.56 °C 0.28 °C 0.56 °C 0.28 °C 0.56 °C 0.28 °C 0.56 °C 0.28 °C 0.95 °C 0.46 °C 0.41 °C 0.41 °C 0.41 °C 0.25 °C 0.21 °C 0.21 °C 0.2 °C 0.2 °C	Fluke 5522A Multifunction Calibrator
Electrical Simulation of Resistance Temperature Indicating Devices ¹	RTD/Thermistor (-200 to - 80) °C (> - 80 to 0) °C (> 0 to 100) °C (> 100 to 300) °C (> 300 to 400) °C (> 400 to 630) °C (> 630 to 800) °C	0.07 °C 0.07 °C 0.081 °C 0.092 °C 0.098 °C 0.12 °C 0.19 °C	Fluke 5522A Multifunction Calibrator



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Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscopes ¹ Square Wave Signal 10 Hz to 10 kHz 50 Ω 1 M Ω Level Sine Wave Amplitude Time Markers (5-2-1 sequence) into a 50 Ω load Rise Time	1 mV to 6.6 V p-p 1 mV to 130 V p-p 5 mV to 5.5 V 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 5 s to 50 ms 20 ms to 100 ns (50 to 20) ns 10 ns (5 to 2) ns ≤ 300 ps	0.25 mV/V p-p + 0.11 V 2.5 mV/V p-p + 58 mV 11 mV/V + 0.11 V 25 mV/V + 0.11 V 30 mV/V + 0.11 V 52 mV/V + 0.11 V 0.3 mHz/Hz + 0.12 Hz 2.5 x 10 ⁻⁶ Hz/Hz 2.5 x 10 ⁻⁶ Hz/Hz 2.5 x 10 ⁻⁶ Hz/Hz 2.5 x 10 ⁻⁶ Hz/Hz 0.06 ps/s + 0.03 ps	Fluke 5522A Multifunction Calibrator
Oscilloscopes ¹ Flatness referenced to 50 kHz reference	(5 to 12) mVp-p 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 600 Hz to 1 GHz 12 mVp-p to 5.5 Vp-p 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 600 Hz to 1 GHz	0.36 dB 0.38 dB 0.47 dB 0.53 dB 0.27 dB 0.29 dB 0.38 dB 0.44 dB	Fluke 5522A Multifunction Calibrator

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Amplitude Modulation – Measure ¹ 150 kHz to 10 MHz 10 MHz to 1.3 GHz	Rate: 50 Hz to 10 kHz, (5 to 99) % Depth	0.044 % Depth + 2.3 % of reading	HP 8902A Measuring Receiver
	50 Hz to 100 kHz, (20 to 99) % Depth	0.012 % Depth + 1.2 % of reading	
Frequency Modulation – Measure ¹ 250 kHz to 10 MHz 10 MHz to 1.3 GHz	Rate: 20 Hz to 10 kHz Dev:20 Hz to 40 kHz peak	0.022 kHz + 2.3 % Deviation	HP8902A Measuring Receiver
	Rate: 50 Hz to 200 kHz Dev:250 Hz to 400 kHz peak	0.16 kHz + 5.8 % Deviation	
Frequency Modulation – Source ¹ 250 kHz to 1 GHz (1 to 2) GHz (2 to 3.2) GHz (3.2 to 10) GHz (10 to 20) GHz	Rate: 1 kHz rate Max. Dev. 2 MHz Max. Dev. 4 MHz Max. Dev. 8 MHz Max. Dev. 16 MHz Max. Dev. 32 MHz	4 % Deviation + 24 Hz	HP 83620B Signal Generator
Phase Modulation – Source ¹ 150 kHz to 10.0 MHz 10 MHz to 1.3 GHz	>0.7 rad Deviation >0.6 rad Deviation	0.003 rad + 4.9 % Deviation 0.067 rad + 3.4 % Deviation	HP 8902A Measuring Receiver
Phase Modulation – Measure ¹ 150 kHz to 10 MHz 10 MHz to 1.3 GHz	Rate:200 Hz to 10 kHz Rate:200 Hz to 20 kHz	4.6 % Deviation + 1 digit 3.5 % Deviation + 1 digit	HP 8902A Measuring Receiver
Distortion – Measure ¹ 20 Hz to 20 kHz (20 to 100) kHz	(0 to 99) dB Rate: 20 Hz to 250 kHz (0.01 to 100) % Distortion	1.2 dB 2.3 dB	HP 8902B Measuring Receiver
Power – Measure ¹ 1 mW reference	1 mW 50 MHz	1.1 % of reading + 0.66 uW	HP 432A Power Meter, HP 478A Thermistor Mount
	(-20 to 30) dB 100 kHz to 4.2 GHz 50 MHz to 26.5 GHz 50 MHz to 50 GHz	3.2 % of reading + 0.22 dB 4 % of reading + 0.26 dB 4.6 % of reading + 0.29 dB	Power Meters with HP 8482A, E4419B, HP 8485A, E4419B, HP 8487A, E4419B Power Sensors
Noise Figure – Source ¹ 10 MHz to 26.5 GHz	15 dB ENR	0.17 dB	HP 346C Noise Source

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Noise Figure – Measure ¹	(5 to 17) dB ENR 100 kHz to 30 MHz 30 MHz to 3 GHz (3 to 26.5) GHz	0.43 dB 0.42 dB 0.47 dB	HP 346C Noise Source, Agilent E4448A Spectrum Analyzer, HP 8449B Preamplifier

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Ring Gages	(1 to 20) mm (> 20 to 50) mm (> 50 to 70) mm (> 70 to 80) mm (> 80 to 100) mm	0.64 μm 1.1 μm 1.3 μm 1.4 μm 1.7 μm	Ring Gauge, Universal Length Measuring Machine
Plain Plug Gauge, Pin Gauge, Thread Measuring Wires	(1 to 10) mm (> 10 to 20) mm (> 20 to 30) mm (> 30 to 40) mm (> 40 to 50) mm (> 50 to 60) mm (> 60 to 70) mm (> 70 to 80) mm (> 80 to 90) mm (> 90 to 100) mm	0.51 μm 0.63 μm 0.67 μm 0.79 μm 0.9 μm 1.3 μm 1.2 μm 1.4 μm 1.5 μm 1.6 μm	Universal Length Measuring Machine
Thread Plug Gages - External Diameter	(1 to 10) mm (> 10 to 100) mm	2 μm 2.5 μm	Universal Length Measuring Machine
Thread Ring Gages - Internal Diameter	(3 to 30) mm (>30 to 100) mm	0.23 μm 0.77 μm	Ring Gauge, Universal Length Measuring Machine
Gage Blocks	Up to 4 in	(14 + 0.8L) μin	Universal Length Measuring Machine
Plug Gage	Up to 4 in	(25 + 1.3L) μin	Universal Length Measuring Machine
Bore Gages	Up to 1 in	110 μin	Mahr ULM 600
Calipers External Diameter	Up to 40 in (Up to 1 000 mm)	13 μin/in + 590 μin	Grade 2 Gage Blocks, End Rods
Inside Diameter (Fixed Points)	(1 and 2) in (25.4 and 50.8) mm	28 μin/in + 660 μin	Ring Gages

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Micrometers and Thickness Gages	Up to 12 in (Up to 300 mm)	30 µin/in + 19 µin	Grade 2 Gage Blocks, End Rods
Height Gages ¹	Up to 300 mm (> 300 to 600) mm (> 600 to 1 000) mm	9 µm 16 µm 25 µm	
Depth Gages	Up to 40 in (Up to 1 000 mm)	21 µin/in + 140 µin	Grade 2 Gage Blocks, End Rods
Dial Indicators	Up to 4 in (Up to 100 mm)	21 µin/in + 1 800 µin	Grade 2 Gage Blocks
Steel Rules	Up to 1 000 mm (> 1 000 to 2 000) mm	0.06 mm 0.075 mm	Linear Scale
Tape Measure	Up to 1 000 mm (1 000 to 2 000) mm (2 000 to 3 000) mm (3 000 to 4 000) mm (4 000 to 5 000) mm (5 000 to 6 000) mm (6 000 to 7 000) mm (7 000 to 8 000) mm (8 000 to 9 000) mm (9 000 to 10 000) mm	0.06 mm 0.07 mm 0.09 mm 0.12 mm 0.14 mm 0.17 mm 0.2 mm 0.22 mm 0.25 mm 0.27 mm	Linear Scale
Feeler (Thickness) Gages	Up to 1 mm	0.14 µm	Mahr ULM 600
Holtest	Extension to 25 mm	0.000 12 % of reading + 0.6 µm	
Optical Comparators and Visual System	Up to 300 mm	0.01 mm	Grade 2 Gage Blocks, Glass Scale

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Force Gages	Up to 20 kgf	24 gf	Class M1 Weights
Air Pressure - Source	(-12 to 300) psi	0.2 psi	Fluke 718 300G Pressure Calibrator
	(300 to 10 000) psi	0.000 1 % of Applied + 9.5 psi	Fluke 700P31 Pressure Gage

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Differential Air Pressure - Source	(0 to 15) psi	0.21 psi	Fluke 700P-24 Pressure Module
Oil Pressure - Source	(0 to 10 000) psi	0.02 % of Applied + 0.21 psi	Fluke P324 Deadweight Tester
Torque Tools	(1 to 10) lbf in (10 to 100) lbf in (5 to 50) lbf ft (25 to 250) lbf ft	0.6 % of Applied + 0.008 lbf in 0.6 % of Applied + 0.07 lbf in 0.6 % of Applied + 0.04 lbf ft 0.7 % of Applied + 0.15 lbf ft	Torque Transducers Mountz LLT10i Mountz BMX100i Mountz BMX50F Mountz BMX250F
Torque Transducers	Up to 22 cm kg	0.03 % of Applied + 0.000 3 cm kg	Mountz 4 in Torque Wheel and Weights
Scales and Balances ^{1,4}	Up to 120 g (> 120 to 220) g (> 220 to 320) g (> 320 to 500) g (> 500 to 600) g (> 600 to 1 000) g (> 1 000 to 1 200) g (> 1 200 to 1 500) g (> 1 500 to 2 000) g (> 2 000 to 3 000) g (> 3 000 to 5 000) g (> 5 000 to 6 000) g (> 6 to 10) kg (> 10 to 20) kg (> 20 to 30) kg	0.31 mg 0.55 mg 0.66 mg 0.7 mg 0.87 mg 2 mg 2.4 mg 2.7 mg 7.6 mg 11 mg 18 mg 20 mg 46 mg 52 mg 95 mg	OIML Class F1 weight set, OIML Class M1 weight set and UKAS LAB 14 utilized in the calibration of the weighing system.
Scales and Balances ^{1,4}	(> 30 to 150) kg (> 150 to 300) kg (> 300 to 500) kg	8 g 10 g 45 g	OIML Class M1 weight set and UKAS LAB 14 utilized in the calibration of the weighing system.
Mass	Up to 100 g Up to 10 kg	0.1 mg 0.01 g	Class F Weights, Balance
Air Velocity	Up to 7 040 fpm	1.2 % of Applied + 1.6 fpm	Interactive Instruments JS500 Wind Tunnel, Omega HHF141A Anemometer

Photometry and Radiometry

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Optical Wavelength – Measure ¹	(700 to 1 650) nm	0.0061 nm	Agilent 86120A Wavelength Meter
Laser Power - Measure	Up to 1 W (1 to 3) W (3 to 10) W (10 to 30) W	0.042 W 0.19 W 0.62 W 2 W	Gentec Maestro UP50N-50H-W9-D0 Power Detector

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature - Measure ¹ Ovens and Chambers	(-50 to 50) °C (50 to 100) °C (100 to 300) °C	0.5 °C 0.62 °C 0.79 °C	Agilent 34970A Datalogger
Temperature - Measure ¹ Dry Well and Liquid Bath	(-200 to 0) °C (0 to 660) °C	0.01 °C 0.02 °C	Fluke 5626 PRT, Agilent 3458A Multimeter
Radiation (Infrared) Thermometers	(10 to 120) °C	1.3 °C	Omega BB701 $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$
	(100 to 150) °C (150 to 425) °C (425 to 982) °C	2 °C 3.9 °C 6 °C	Omega BB-4A $\epsilon = 0.99, \lambda = (8 \text{ to } 14) \mu\text{m}$
Relative Humidity - Measure, Ovens and Chambers ¹	Up to 95 %RH	1.5 %RH	Sansel HTD-200 Temperature/Humidity Indicator and Probe
Platinum Resistance Thermometers	(-15 to 100) °C (100 to 350) °C	0.001 8 % + 0.006 °C 0.002 2 % + 0.006 °C	Fluke 9009 Drywell, HP 3458A Multimeter, Fluke 5626 PRT
Thermocouple Sensors	(-15 to 350) °C	0.11 °C	Fluke 9009 Drywell, HP 3458A Multimeter, Fluke 5626 PRT

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Source ¹	1 μHz to 80 MHz 10 MHz to 50 GHz	5×10^{-12} Hz 5×10^{-12} Hz	Signal Generators HP 33250A, Agilent 8340B, Agilent 83650B



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Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Source ¹	Up to < 120 Hz 120 Hz to < 1.2 kHz (1.2 to < 12) kHz (12 to < 120) kHz 120 kHz to <1.2 MHz (1.2 to < 2) MHz	2.9 μHz/Hz + 59 μHz 2.9 μHz/Hz + 0.59 mHz 2.9 μHz/Hz + 5.8 mHz 2.9 μHz/Hz + 58 mHz 2.9 μHz/Hz + 0.59 Hz 2.9 μHz/Hz + 5.8 Hz	Fluke 5522A Multifunction Calibrator
Frequency – Measure ¹	1 μHz to 12.4 GHz	5 x 10 ⁻¹² Hz	HP 53132A Opt 124 Counter
Frequency – Measure ¹	1 Hz to 26.5 GHz	5 x 10 ⁻¹² Hz	Agilent E4440A Spectrum Analyzer
Frequency – Measure ¹	10 Hz to 46 GHz	5 x 10 ⁻¹² Hz/Hz	Agilent 53152A Counter
Stopwatches/Timers	Up to 3 600 s 0.5 s to 240 min	0.25 s 0.033 ms	HP 53132A Counter with HP 33250A Signal Generator
RPM – Source Non-Contact	(0 to 60) RPM (60 to 3 000) RPM (3 000 to 6 000) RPM (6 000 to 12 000) RPM (12 000 to 60 000) RPM (60 000 to 100 000) RPM (100 000 to 120 000) RPM	0.36 part per 10 ⁶ + 0.000 58 RPM 0.36 part per 10 ⁶ + 0.000 58 RPM 0.36 part per 10 ⁶ + 0.005 8 RPM 0.36 part per 10 ⁶ + 0.005 8 RPM 0.36 part per 10 ⁶ + 0.058 RPM 0.36 part per 10 ⁶ + 0.58 RPM 0.36 part per 10 ⁶ + 5.8 RPM	Agilent 33250A Signal Generator
RPM – Measure Stroboscopes	Up to <100 rpm (100 to <1000) rpm (1 000 to 100 000) rpm	0.0013 rpm 0.0059 rpm 0.058 rpm	Agilent 34401A Multimeter, HP 53132A Counter

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 ($k=2$), corresponding to a confidence level of approximately 95%.

Notes:

1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope
2. The use of (L) signifies Length in inches.
3. The nominal values listed are approximate.
4. The CMC for scales and balances are highly dependent upon the resolution of the unit under test. The uncertainty presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
5. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1736.08.

Jason Stine, Vice President